

**U.S. FISH AND WILDLIFE SERVICE  
SPECIES ASSESSMENT AND LISTING PRIORITY ASSIGNMENT FORM**

SCIENTIFIC NAME: *Trichomanes punctatum* Poir. subsp. *floridanum* Wess. Boer

COMMON NAME: Florida bristle fern (= Fragrant bristle fern, Filmy fern, Dotted bristle fern)

LEAD REGION: 4

INFORMATION CURRENT AS OF: April 2010

**STATUS/ACTION**

☐ Species assessment - determined we do not have sufficient information on file to support a proposal to list the species and, therefore, it was not elevated to Candidate status

☐ New candidate

☒ Continuing candidate

☒ Non-petitioned

☐ Petitioned - Date petition received:

☐ 90-day positive - FR date:

☐ 12-month warranted but precluded - FR date:

☐ Did the petition request a reclassification of a listed species?

☐ Listing priority change

Former LP:

New LP:

Date when the species first became a Candidate (as currently defined): November 9, 2009

☐ Candidate removal: Former LPN:

☐ A – Taxon is more abundant or widespread than previously believed or not subject to the degree of threats sufficient to warrant issuance of a proposed listing or continuance of candidate status.

☐ U – Taxon not subject to the degree of threats sufficient to warrant issuance of a proposed listing or continuance of candidate status due, in part or totally, to conservation efforts that remove or reduce the threats to the species.

☐ F – Range is no longer a U.S. territory.

☐ I – Insufficient information exists on biological vulnerability and threats to support listing.

☐ M – Taxon mistakenly included in past notice of review.

☐ N – Taxon does not meet the Act's definition of "species."

☐ X – Taxon believed to be extinct.

ANIMAL/PLANT GROUP AND FAMILY: Ferns and Allies, Hymenophyllaceae, Filmy fern family

HISTORICAL STATES/TERRITORIES/COUNTRIES OF OCCURRENCE: Florida, U.S.A.

CURRENT STATES/COUNTIES/TERRITORIES/COUNTRIES OF OCCURRENCE: Florida, Miami-Dade and Sumter Counties, U.S.A.

LAND OWNERSHIP: All known populations of Florida bristle fern are on public lands in two counties. In Sumter County, one population is on the 63,729 hectare (ha) (157,477 acre (ac)) Withlacoochee State Forest (C. Werner, Withlacoochee State Forest, pers. comm. 2007). Another population consisting of two colonies reported on private land just south of the State Forest may be extirpated. In Miami-Dade County the taxon is known from three areas owned by Miami-Dade County: Castellow Hammock Park (39.5 ha [97.6 ac]), Fuchs Hammock Preserve (10.2 ha [25.5 ac]), and Meissner Hammock (4.1 ha [10.1 acres]). Florida bristle fern occurs in small portions (i.e., < 0.5 ha [1.2 ac]) of each site. Of the habitat occupied at the four sites, approximately 75 percent is owned by Miami-Dade County and 25 percent by the State of Florida, but the exact proportion is difficult to estimate.

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#### BIOLOGICAL INFORMATION

Species Description: The Florida bristle fern is a very small, mat-forming fern, superficially resembling some liverwort species. Wunderlin and Hansen (2000, p. 153-154) described it as “Stem long-creeping, mat forming, the trichomes (hairlike or bristlelike outgrowth) brownish black, of 2 types, 2-celled glandular and elongate rhizoidlike ones; roots absent. Leaves separated, the petiole 0.1-2 centimeters (cm) long, usually shorter than the blade, pubescent above and below with trichomes like those of the stem but shorter, with stellate (star-shaped) trichomes few and distal on the winged upper part, the blade flabellate (fan-shaped), round, narrowly oblanceolate to nearly linear, entire or irregularly lobed at the apex, 0.5-2 cm long, 0.2-1.1 cm wide, the midrib wanting or less than ½ the blade length, the apex rounded to obtuse, the base narrowly cuneate (wedge-shaped), the margin entire to irregularly and flabellately lobed, lobes oblong and blunt to obscurely deltoid, frequently resembling proliferous outgrowths distally, with marginal black stellate trichomes, with 2-celled glandular trichomes on the veins, false veins few, the true veins not enlarged at their apex. Involucres (series of bracts beneath or around a flower or flower cluster) 1.5-2 millimeters (mm) long, 1-6 at the blade apex, immersed for ½ or more of their length to fully so, the lips distinct from the blade tissue, inconspicuously dark-margined, the receptacle included or exserted to less than about ½ the involucre length.”

Taxonomy: The genus *Trichomanes* is mostly tropical, with about 300 species. A few species grow in temperate regions. When Florida bristle fern was first discovered in Miami-Dade County it was referred to as *T. sphenoides* Kunze (Eaton 1906, p. 460; Small 1913, p. 4). Underwood (1906, p. 201) treated Miami-Dade plants as *Didymoglossum sphenoides* (Kunze) Presl. John Kunkel Small later determined the plants in Miami-Dade County to be *T. punctatum* (Small 1918a, p. 6; Small 1918b, p. 4; Small 1931, p. 35). After it was found in Sumter County in 1936, John Kunkel Small referred the Miami-Dade plants to *T. punctatum* and the Sumter

plants to *T. sphenoides* (Small 1938, p. 48-50). This treatment was followed by Wherry (1964, p. 232). The current taxonomy of *Trichomanes punctatum* is the result of monographic revision of *Trichomanes* sections *Didymoglossum* and *Microgonium* by Wessels Boer (1962, p. 300-301). *Trichomanes punctatum* was treated in Section *Didymoglossum*. Wessels Boer, in reviewing specimens from throughout the American tropics, determined that all Florida plants represented the same taxon, not two separate species, and that *T. sphenoides* (which he described as *T. punctatum* subsp. *sphenoides*) only occurred in tropical America and not in Florida. He further determined that the Florida plants were different from those in the tropics and described them as a new subspecies, *Trichomanes punctatum* subsp. *floridanum* (Wessels Boer 1962, p. 300-301). This treatment has been followed by almost all subsequent authors (Lakela and Long 1976, p. 53; Wunderlin 1982, p. 32; Lellinger 1985, p. 205; Nauman 1986, p. 181; Flora of North America Editorial Committee 1993, p. 196; Wunderlin 1998, p. 44; Nelson 2000, p. 81; Wunderlin and Hansen 2000, p. 153; Wunderlin and Hansen 2003, p. 44), the only exception being Long and Lakela (1971, p. 73), who treated it as *T. punctatum* without further explanation.

The Integrated Taxonomic Information System (2010, p. 1) uses the name *Trichomanes punctatum* ssp. *floridanum* and indicates that this species' taxonomic standing is accepted. NatureServe (2009, p. 1) uses the name *T. punctatum* ssp. *floridanum*. The online Atlas of Florida Vascular Plants (Wunderlin and Hansen 2008, p. 1-2) uses the name *T. punctatum* ssp. *floridanum*. In summary, there is consensus that *T. punctatum* ssp. *floridanum* is a distinct taxon. We have carefully reviewed the available taxonomic information to reach the conclusion that the subspecies is a valid taxon.

Habitat/Life History: Florida bristle fern is always associated with shaded limestone outcrops. Plants usually grow on bare limestone, but are occasionally found on tree roots growing on limestone. In Miami-Dade County, it has been found exclusively in oolitic (composed of minute rounded concretions resembling fish eggs) limestone solution holes and rocky outcrops in rockland hammocks. Solution holes are formed by dissolution of subsurface limestone followed by a collapse above (Snyder *et al.* 1990, p. 236). Solution holes vary in size, from shallow holes less than 0.5 meter (m) (1.6 feet [ft]) deep, to those that cover over 100 m<sup>2</sup> (1,076 ft<sup>2</sup>) and are several meters deep. The bottoms of most solution holes are filled with deep organic soils. Deeper solution holes penetrate the water table and have (at least historically) standing water for part of the year. Humidity levels are higher in and around the solution holes because of standing water and moisture retained in the organic soils.

The canopy cover is typically very dense where Florida bristle fern occurs, and consists of a mix of temperate and tropical hardwood trees including lancewood (*Ocotea coriacea*), pigeon plum (*Coccoloba diversifolia*), live oak (*Quercus virginiana*), paradise tree (*Simarouba glauca*), strangler fig (*Ficus aurea*), and mastic (*Sideroxylon foetidissimum*) (K. Bradley, pers. comm. 2007). Many tropical, epipetric plant species are associated with solution holes in rockland hammocks. Soils at the Miami-Dade County sites are classified as Matecumbe Muck (<http://www.fgdl.org/>). In Sumter County, the plants occur in a mesic/hydric hammock on limestone boulders 1 - 2 m (3.3 - 6.6 ft) tall, under a canopy of live oak, cabbage palm (*Sabal palmetto*), and American hornbeam (*Carpinus caroliniana*) (C. Werner, pers. comm. 2007). Florida bristle fern grows on boulders with tall, horizontal faces with other rare fern species (e.g., hemlock spleenwort [*Asplenium cristatum*], and widespread polypody [*Pecluma dispersa*]). The

hammocks where it has been found are surrounded by a mosaic of wetlands. Soils at the Sumter County station are classified as Mabel Fine Sand, bouldery subsurface (<http://www.fgdl.org/>).

Little is known about the life history of this taxon, or for members of the genus in general. Like all ferns, Florida bristle fern has two life history stages, a gametophyte stage and a sporophyte stage. All populations that have been reported have been in the sporophyte stage. The initial stage, after a spore germinates, is the gametophyte stage. The gametophyte contains separate sperm and egg producing structures. In the presence of water or moisture, sperm reach the eggs for fertilization. Fertilized eggs, under the proper conditions, develop into sporophytes – the typical form most ferns are observed in. The sporophytes produce spores which in turn can germinate to produce new gametophytes (Nelson 2000, p. 17-19). Reproduction may also occur in two other ways. Plants may reproduce by division, when rhizomes break, forming clones of the parent plant. They may also reproduce with the production of gemmae, propagules produced by gametophytes, which can grow into new gametophytes of the same genotype (Hill 2003, p. 12).

Spores have been recorded in October (J. Possley, pers. comm. 2007), but plants probably produce spores during much of the summer wet season. During the dry season, sporophytes have been observed to desiccate, and probably do not produce spores. For Florida bristle fern, the reproductive requirements, such as moisture levels, needed for each stage of its life history are unknown. Data are needed on longevity, growth rates, recruitment rates, dispersal methods, and genetic variation.

Historical Range/Distribution: The historical range of Florida bristle fern included southern (Miami-Dade County) and central (Sumter County) Florida. In Miami-Dade County it occurred historically in at least 12 hammocks (Castellow, Cox, Fuchs, Hattie Bauer, Meissner, Modello area, Nixon-Lewis, Ross, Royal Palm, Shields, Silver Palm, Snapper Creek area) (Gann *et al.* 2002, p. 552-554). The range extended from Royal Palm Hammock (now in Everglades National Park [ENP]) at its southern limit, north to at least Snapper Creek, and possibly further north into the Miami area (Gann *et al.* 2002, p. 552-554). This is a range of at least 45 kilometers (km) (28 miles [mi]).

John Kunkel Small called attention to the demise of this taxon because of habitat destruction in 1938 (Small 1938, p. 50). Sites that have been destroyed include a station (study location) near the City of Miami, the Snapper Creek area, a hammock near Modello (in southern Miami-Dade County near the intersection of U.S.1 and S.W. 288 Street), Shields Hammock, and a hammock near Longview Camp (between Florida City and ENP). Some other hammocks still exist where the taxon formerly occurred. These include Cox Hammock (privately-owned Monkey Jungle tourist attraction) where it was last seen in 1989, Hattie Bauer Hammock (preserve owned by Miami-Dade County, formerly the Orchid Jungle tourist attraction) where it was last seen in 1988, Silver Palm Hammock (preserve owned by Miami-Dade County) where it was last seen around 1980, Nixon-Lewis Hammock (privately-owned, disturbed, and mostly destroyed) where it was collected in 1915, and Royal Palm Hammock (in ENP) where it was last reported in 1917 or earlier (Gann *et al.* 2002, p. 552-554). It has also been reported for the Deering Estate at Cutler and Matheson Hammock Park, both Miami-Dade County Parks, but these reports were never confirmed (Gann *et al.* 2002, p. 552-554).

In Sumter County, Florida bristle fern has been documented to occur only in a small area (Wunderlin and Hansen 2000, p. 154). All of the known collections are from the vicinity of the town of Wahoo. However, most herbarium label data are imprecise. Essentially all verified collections have been made from the area just north of Wahoo, which is east of the Withlacoochee River. The only known population in Sumter County still occurs in this area and is approximately 2 km (1.2 mi) north of Wahoo.

Two specimens have label data that indicate that the specimens were not collected north of Wahoo, but the label data on both of these are suspect. One specimen in 1963, Lakela #26474 (University of South Florida herbarium), was collected at “Indian Field Ledges west of Withlacoochee River off #48.” If this label data are correct, this station was about 6.0 - 6.5 km (3.7 – 4.0 mi) to the west of Wahoo. The statement that it was west of the river may be in error, as Darling (1961, p. 7) stated that the Indian Field Ledges are north of Wahoo, a locality east of the river. Another specimen collected in 1939 (three years after its discovery in Florida, when it was thought to be *T. sphenoides*) has the label data “south of Floral City, FL. This is the only known station in the United States.” It was collected by J.B. McFarlin (Florida State University herbarium). Wahoo is approximately 11.3 km (7.0 mi) southeast of Floral City. The label data may be incorrect and probably refer to the population in the Wahoo area. Because of the new report of the taxon from that area, McFarlin probably collected at the same locality where the taxon was found in 1936 and incorrectly recorded the direction from Floral City as south instead of southeast. The specimen has led to reports of the taxon in Citrus County (Wherry 1964, p. 232; Nelson 2000, p. 81).

Current Range/Distribution: There are currently four, and possibly five, extant occurrences of Florida bristle fern (Gann *et al.* 2002, p. 552-554), three in Miami-Dade County and two in Sumter County (Table 1). The Sumter County occurrences are approximately 400 km (249 mi) north of those in Miami-Dade County.

Table 1: Summary of known, extant occurrences of Florida bristle fern. Data are from Gann *et al.* (2002, p. 552-554), K. Bradley (pers. comm. 2009), and J. Possley (pers. comm. 2008).

<i>County</i>	<i>Location</i>	<i>Ownership</i>	<i># of colonies</i>	<i>Status</i>
Miami-Dade	Meissner Hammock <sup>1</sup>	Public	2	Extant
	Fuchs Hammock Preserve <sup>2</sup>	Public	3	Extant
	Castellow Hammock Park <sup>3</sup>	Public	2+	Extant
Sumter	Withlacoochee State Forest's Jumper Creek Tract <sup>4</sup>	Public	1	Extant
	Private land south of Jumper Creek Tract <sup>5</sup>	Private	2	Unknown

In Miami-Dade County, Florida bristle fern is known from Meissner Hammock<sup>1</sup> in two solution holes (K. Bradley, pers. comm. 2009), from Fuchs Hammock Preserve<sup>2</sup> in three solution holes, and from Castellow Hammock Park<sup>3</sup> in two large solution holes and several smaller holes and rocky outcroppings (J. Possley, pers. comm. 2008). Fuchs and Meissner Hammocks are immediately adjacent to each other, and Castellow Hammock Park is 10.5 km (6.5 mi) to the

northeast. In Sumter County it is known from one colony in the Withlacoochee State Forest's Jumper Creek Tract<sup>4</sup>, north of Wahoo. Another occurrence consisting of two colonies on private land just south of the State Forest<sup>5</sup> may be extirpated.

While no comprehensive status survey has been conducted, rockland hammocks in Miami-Dade County with suitable habitat have been extensively explored, including sites where it was formerly found. It is unlikely that additional surveys will reveal new occurrences in Miami-Dade County. However, it is possible that Florida bristle fern occurs at some of the hammocks or hammock fragments that remain intact. It is possible that three or four hammocks may be sufficiently intact to support the species (K. Bradley, pers. comm. 2009). Attempts to relocate the taxon in Royal Palm Hammock in ENP have not been successful (Gann *et al.* 2006, p. 10; J. Sadle, ENP, pers. comm. 2008a), and additional surveys there are not expected to be successful (J. Sadle, pers. comm. 2008b). Surveys of Hattie Bauer Hammock in 2005 and 2006 were unsuccessful (K. Bradley, pers. comm. 2007). It could not be found in surveys of Silver Palm Hammock in the late 1990s and early 2000s (Gann *et al.* 2002, p. 552-554). It could not be found in Nixon-Lewis Hammock in 2004, although what remains of the hammock is so disturbed that finding it was extremely unlikely (K. Bradley, pers. comm. 2007). Extensive surveys have not been undertaken at Cox Hammock, and the species may persist there (K. Bradley, pers. comm. 2008).

Also, new locations could be encountered in Sumter County. The soil type of the known occurrence in Sumter County covers 1,478 ha (3,652 acres), and these areas have not been systematically surveyed. In August 2007, a boulder field in the Withlacoochee State Forest's Jumper Creek Tract called the Indian Fields was explored without success (C. Werner, pers. comm. 2007). The hammocks in the vicinity of the known colony have also been searched without finding additional colonies (C. Werner, pers. comm. 2007). A systematic survey of all potential and suitable habitat in and around Sumter County is needed (see Recommended Conservation Measures below).

Population Estimates/Status: Because Florida bristle fern grows in dense mats and is rhizomatous, it is difficult, if not impossible, to accurately count individual plants. This difficulty has been encountered in other *Trichomanes* species, such as Appalachian bristle fern (*Trichomanes boscianum*) (Hill 2003, p. 11). In Miami-Dade County the taxon occurs at three sites in seven solution holes and several smaller holes and rocky outcroppings (J. Possley, pers. comm. 2008). Possley has estimated that individual colonies cover from 30 cm<sup>2</sup> (4.7 inches<sup>2</sup> [in]) to a maximum of 400 cm<sup>2</sup> (62 in<sup>2</sup>) on the walls of solution holes. The total area covered by the colonies at the six solution holes is roughly 810 cm<sup>2</sup> [125.6 in<sup>2</sup>]. There are probably less than 500 total plants, and many plants may be genetically identical, since new plants can arise from broken rhizomes. In Sumter County, the single small colony grows on five or six boulders and covers approximately 0.3 m<sup>2</sup> (3.0 ft<sup>2</sup>) (C. Werner, pers. comm. 2007). There are probably fewer than 1,000 total plants in existence, but this may be a large overestimate of the actual number (K. Bradley, pers. comm. 2007).

The Florida Natural Areas Inventory (FNAI) considers the State status of the Florida bristle fern to be S1, "critically imperiled in Florida because of extreme rarity (five or fewer occurrences or less than 1000 individuals) or because of extreme vulnerability to extinction due to some natural

or man-made factor” (FNAI 2010a, p. 9; 2010b, p. 20). NatureServe (2009, p. 1-2) gives its global short-term trend as declining with a rounded global status of T1, critically imperiled, due to extreme rarity and threats from drainage, conversion of habitat, and exotic plants. The Institute for Regional Conservation (IRC) considers its status as “critically imperiled” (Gann *et al.* 2001-2008, p. 1). The Florida bristle fern is listed as endangered by the State.

## THREATS

- A. The present or threatened destruction, modification, or curtailment of its habitat or range. Habitat loss and modification have severely impacted the Florida bristle fern in Miami-Dade County. Most of the sites where Florida bristle fern once occurred have been destroyed. Rockland hammocks once occurred across the Miami-Rock Ridge, usually in association with pine rocklands, or the edges of marl prairies or tidal swamps (Service 1999, p. 122). Because of extensive development in the County, there have been losses of all habitat types. About 263 ha (650 acres) of this formerly abundant rockland hammock ecosystem remains outside of ENP (K. Bradley, pers. comm. 2007). Much of this hammock area is degraded due to former land clearing and invasive exotic plants. The area between Fuchs/Meissner Hammocks and Castellow Hammock contains housing developments and agricultural lands, with only scattered, small fragments of natural areas, and almost no habitat for the taxon remains.

Miami-Dade County has purchased many rockland hammocks under the Environmentally Endangered Lands Program, and many other hammocks are owned by the Miami-Dade County Parks and Recreation Department. Although some hammocks remain in private ownership, most remaining habitat is now fragmented and degraded (e.g., impacted by current or previous land uses, exotic plants). One exception is the privately owned Cox Hammock at Monkey Jungle, where habitat is largely intact. However, since this site is unprotected, habitat alteration can occur at any time. If there are occurrences of Florida bristle fern remaining on site, these occurrences could be negatively affected by a change in land use or management. Overall, it is unlikely that any significant new acreage will be acquired or any new occurrences will be found in Miami-Dade County in the future. Development is no longer a significant threat for this taxon in this County; most occurrences have been previously destroyed, and most remaining habitat is now publicly owned.

Regional drainage is now the major threat to Florida bristle fern in Miami-Dade County. Drainage efforts that began soon after the County was settled, primarily to make land more suitable for agriculture and development, have resulted in a region-wide drop in the water table (Lodge 2005, p. 222). This drainage has impacted rockland hammocks and their flora (Austin *et al.* 1987, p. 5-6; Service 1999, p. 3-138), including Florida bristle fern. Hammocks on limestone substrates are dependent on the underlying water table to keep humidity levels high, especially in limestone sinkholes (Service 1999, p. 3-127). Regional drainage due to canal construction has probably been a stressor that has contributed to extirpations and population declines (Nauman 1986, p. 182). Throughout Miami-Dade County, solution holes now contain much less, if any, water during much of the year, and ambient humidity levels have dropped (Nauman 1986, p. 182, K. Bradley, pers. comm. 2008). This threat is so severe that Miami-Dade County has discussed the possibility of

pumping water into solution holes with rare ferns (K. Bradley, pers. comm. 2009).

Any habitat modification that changes ambient humidity levels is a threat to Florida bristle fern (Nauman 1986, p. 182). Drops in ambient humidity may limit reproduction and health of populations over the long-term. Even if the change in humidity does not cause extirpation, it may make plants more vulnerable to other stressors, such as periodic long-term droughts or hurricanes (see Factor E). Drainage effects and resulting changes to ambient humidity levels are continuing threats to all occurrences in Miami-Dade County. Ground water levels in the vicinity of Florida bristle fern occurrences are not targeted as part of Everglades restoration. Consequently, the Everglades restoration is not expected to ameliorate the threats posed by regional drainage. In short, the threats from regional drainage and resulting changes to habitat conditions for the Florida bristle fern are difficult to address and expected to continue.

Climatic changes and sea level rise are major threats to south Florida, including this species and its habitat. The Intergovernmental Panel on Climate Change (IPCC) reported that the warming of the world's climate system is unequivocal based on documented increases in global average air and ocean temperatures, unprecedented melting of snow and ice, and rising average sea level (IPCC 2007, p. 2; 2008, p. 15). Sea-level rise is the largest climate-driven challenge to low-lying coastal areas and refuges in the sub-tropical ecoregion of southern Florida (U.S. Climate Change Science Program [CCSP] 2008, p. 5-31, 5-32). The long-term record at Key West shows that sea level rose on average 0.088 inches (0.224 cm) annually between 1913 and 2006 (National Oceanographic and Atmospheric Administration [NOAA] 2008, p. 1). This equates to approximately 8.76 inches (22.3 cm) over the last 100 years (NOAA 2008, p. 1).

IPCC (2008, p. 28) emphasized it is very likely that the average rate of sea-level rise during the 21<sup>st</sup> century will exceed that from 1961 to 2003 (i.e., 0.071 inches [0.18 cm] per year), although it was projected to have substantial geographical variability. Partial loss of the Greenland and/or Antarctic ice sheets could result in many feet (several meters) of sea-level rise, major changes in coastlines, and inundation of low-lying areas (IPCC 2008, p. 28-29). Low lying islands and river deltas will incur the largest impacts (IPCC 2008, p. 28-29). Because dynamic ice flow processes in ice sheets are poorly understood, timeframes are not known; however, modeling indicates that "more rapid sea-level rise on century timescales cannot be excluded" (IPCC 2008, p. 29). According to CCSP (2008, p. 5-31), much of low-lying, coastal south Florida "will be underwater or inundated with salt water in the coming century."

IPCC (2008, p. 3, 103) concluded that "climate change is likely to increase the occurrence of saltwater intrusion into coastal aquifers as sea level rises," and that, "sea-level rise is projected to extend areas of salinisation of groundwater and estuaries, resulting in a decrease of freshwater availability for humans and ecosystems in coastal areas". From the 1930s to 1950s, increased salinity of coastal waters contributed to the decline of cabbage palm forests in southwest Florida (Williams *et al.* 1999, p. 2056-2059), expansion of mangroves into adjacent marshes in the Everglades (Ross *et al.* 2000, p. 9, 12-13), and loss of pine rockland in the Keys (Ross *et al.* 1994, p. 144, 151-155). Hydrology has a strong influence on plant distribution in these and other coastal areas (IPCC 2008, p. 57). Such communities typically



grade from salt to brackish to freshwater species. Human developments will also likely be significant factors influencing whether natural communities can move and persist (IPCC 2008, p. 57; CCSP 2008, p. 7-6).

The Science and Technology Committee of the Miami-Dade County Climate Change Task Force (MDCCCTF) (2008, p. 1) recognized that significant sea level rise is a very real threat to the near future for Miami-Dade County. In a January 2008 statement, the MDCCCTF (2008, p. 2-3) warned that sea-level is expected to rise at least 3-5 feet (0.9-1.5 m) within this century. With a 3-4 foot (0.9-1.2 m) rise in sea level (above baseline) in Miami-Dade County: “Spring high tides would be at about + 6 to 7 feet; freshwater resources would be gone; the Everglades would be inundated on the west side of Miami-Dade County; the barrier islands would be largely inundated; storm surges would be devastating; landfill sites would be exposed to erosion contaminating marine and coastal environments. Freshwater and coastal mangrove wetlands will not keep up with or offset sea level rises of two feet per century or greater. With a five foot rise (spring tides at nearly +8 feet), Miami-Dade County will be extremely diminished,” (MDCCCTF 2008, p. 2-3).

Agricultural conversion and development are potential threats in Sumter County, in places where Florida bristle fern still occurs on private lands. Since a full survey of suitable habitats for Florida bristle fern has never been conducted in Sumter County and it is possible that new colonies may be found, we cannot determine the extent of losses of this species due to habitat destruction and modification (K. Bradley, pers. comm. 2007). Privately owned land in the area around Wahoo where the species has been recorded in the past is zoned as “agricultural” on the Sumter County Future Land Use Map ([http://sumtercountyfl.gov/plandevlop/planning/compplan/land\\_use.pdf](http://sumtercountyfl.gov/plandevlop/planning/compplan/land_use.pdf)). This designation limits development to one unit per 4 ha (10 acres), but does not prevent losses of habitat from development or changes in land use. One hammock where a population was observed in 1999 was recently cleared for pasture (C. Werner, pers. comm. 2007); it is not clear if this occurrence still persists or not (K. Bradley, pers. comm. 2007). Although Sumter County code provides limited protection for rare plants on private land (see Factor D), any undocumented occurrences and suitable habitat on private lands where reintroduction or recolonization may be possible are at risk to land-clearing activities, agricultural conversions, and development. Continued agricultural development may prevent reintroduction or recolonization outside of protected areas.

The impacts of habitat fragmentation on Florida bristle fern persistence are unknown. As indicated above, the area between Fuchs/Meissner Hammocks and Castellow Hammock is now filled by suburbs and agricultural lands, with only scattered small fragments of natural areas and almost no available suitable habitat. For many plant species, fragmentation limits dispersal. For Florida bristle fern, the impacts are not clear since we lack information and understanding of dispersal mechanisms. Habitat fragmentation is a potential threat.

In summary, habitat loss and modification have severely impacted the Florida bristle fern in Miami-Dade County. However, since nearly all habitat has been destroyed and most suitable fragments remaining are protected, the threat of habitat loss and modification from development in this County is low and nonimminent. Regional drainage and resulting

changes in habitat conditions are now severe threats to the Florida bristle fern in Miami-Dade County. Any habitat modification that changes ambient humidity levels for the plant is of serious concern. Since these stressors are currently occurring and attributed to population declines, these threats are imminent and severe in magnitude. Occurrences in Miami-Dade County are in low-lying areas that will be affected by rising sea level. The threat level of habitat loss from sea-level is currently low, but expected to become severe in the future.

Agricultural conversions and development on private lands in Sumter County are potential threats. Any undocumented occurrences and suitable habitat on private lands are at risk to land-clearing activities, agricultural conversions, and development. However, since a full survey of suitable habitat has not been completed, it is not possible to determine the magnitude or immediacy of these potential threats at this time. Impacts of habitat fragmentation on persistence are unknown; habitat fragmentation is a potential threat.

- B. Overutilization for commercial, recreational, scientific, or educational purposes. None known. Overutilization is not a threat at this time.
- C. Disease or predation. A fungus has been found to coexist on cultivated sporophytes that have been transplanted from the wild (Possley and Maschinski 2006, p. 32-33). This fungus is probably present in the wild. In cultivation, it has killed individual fronds, but not whole plants. At this time, we cannot assess the extent to which the fungus may be impacting wild populations. The fungus is a potential threat to wild populations, the extent of which is unknown.
- D. The inadequacy of existing regulatory mechanisms. The Florida Department of Agriculture and Consumer Services has designated *Trichomanes punctatum* Poir, which includes subspecies *floridanum* Boer, as endangered under Chapter 5B-40, Florida Administrative Code. This listing regulates commercial trade, but provides little or no habitat protection beyond the State's Development of Regional Impact process. This process serves to disclose impacts from projects, but provides no regulatory protection for State listed plants on private or Federal lands.

Occurrences on public conservation lands are afforded some protection. In Miami-Dade County the three preserves where Florida bristle fern exists are managed by the County. In Sumter County the occurrences are on State land in the Withlacoochee State Forest. There is essentially no risk of development or land clearing at these colonies. Although these occurrences are afforded protection from outright destruction, changes in the surrounding landscape that affect the species are not regulated. Regional drainage and resulting habitat changes (e.g., changes in ambient humidity levels) are not regulated, and there are no real regulatory mechanisms in place to raise water table levels on the Miami Rock Ridge.

Any undocumented occurrences and suitable habitat on private lands are at-risk. In Miami-Dade County, it is possible that the species still occurs on one site in private ownership, but occurrences on private land elsewhere in the County are unlikely (K. Bradley, pers. comm. 2007). This site, Cox Hammock, is part of the Monkey Jungle, a local tourist attraction. The property receives limited protection under the Miami-Dade County Environmental Protection

Ordinance as a Natural Forest Community (NFC). Under County code, only portions of NFCs can be cleared, and this clearing must be done after obtaining a permit from Miami-Dade County. Landowners can apply for a permit and destroy Florida bristle fern's habitat on this site, but because the presence of the hammock on the site contributes to the tourist experience (i.e., provides habitat for the monkeys on the property); clearing is unlikely at this time (K. Bradley, pers. comm. 2007). However, because the site is private, smaller disturbances (e.g., filling of solution holes with debris) are possible; such activities can be done without County permits and are known to occur within hammocks within Miami-Dade County (K. Bradley, pers. comm. 2007, 2010). These types of activities can harm or extirpate the taxon, if it does exist on this site (K. Bradley, pers. comm. 2007, 2010). Similarly, a change in ownership or land-use may cause extirpation or negatively impact suitable habitat.

Sumter County has not been well surveyed and there is greater potential for finding additional occurrences of Florida bristle fern on private lands in Sumter County than in Miami-Dade County. Therefore, any undocumented occurrences and any suitable habitat which could be important for reintroduction or recolonization of Florida bristle fern on private lands in Sumter County are potentially at-risk. Since a full survey for the Florida bristle fern or its habitat has not been completed in Sumter County (K. Bradley, pers. comm. 2010), it is not possible to determine the extent of this threat at this time. Sumter County code provides limited protection for rare plants on private land. Under Sec. 13-644(a)(1) "Major developments shall identify and protect habitats of protected wildlife and vegetation species", and in Sec. 13-644(a)(1)2.b.2. "No permit will be issued for development which results in unmitigated destruction of specimens of endangered, threatened or rare species." This legislation provides protection under a limited set of circumstances (i.e., large planned developments), but does not prevent most activities that could harm Florida bristle fern. While County code provides some protection to endangered species, the existing ordinance probably does not apply to actions that would occur on most suitable habitat or potential locations for the fern. County code prevents unmitigated destruction of endangered species only when associated with "major developments." Current zoning in the Wahoo area limits development to one unit per 4 ha (10 acres), so "major developments" do not seem to be likely in that area. In general, there are no laws preventing conversion of habitat to agricultural use, or building on sites with endangered plant species. Without complete survey information for Sumter County, it is difficult to assess the extent to which unknown occurrences and suitable habitat on private lands are at-risk. However, since habitat conversions are continuing, the lack of adequate regulatory mechanisms is a threat for the species and its habitat on private lands within the Sumter County.

In summary, all verified occurrences are afforded some protection by occurring on public conservation lands. Although protected from outright destruction, changes in the surrounding landscape that affect the species are not regulated. Regional drainage and resulting habitat changes (e.g., changes in ambient humidity levels) are not regulated. The lack of regulatory mechanisms to address regional drainage is high and imminent. County codes provide some protection to State endangered species on private lands, but existing ordinances do not apply to actions that would occur on most suitable habitat and potential locations for the fern. Undocumented occurrences and suitable habitat on private lands are

at-risk to unregulated habitat conversions or smaller actions (e.g., filling solution holes). In Miami-Dade County, these threats are low and nonimminent since most remaining suitable habitat is now protected. In Sumter County, where potential for finding Florida bristle fern occurrences and suitable habitat on private lands is greater, threats from inadequate regulatory mechanisms are moderate and imminent.

- E. Other natural or manmade factors affecting its continued existence. Together the four extant Florida bristle fern occurrences probably contain fewer than 1,000 plants (K. Bradley, pers. comm. 2007). Many plants are probably clones, so there may be limited genetic diversity within sites (K. Bradley, pers. comm. 2007). Because there are few occurrences, populations contain few plants, and genetic variability is likely low, the species is inherently at risk due to stochastic events (Matthies *et al.* 2004, p. 481-488). These stochastic events are expected to exacerbate the impacts of regional drainage and subsequent drops in humidity, and cause extirpations. Overall resiliency is low. Stressors such as drainage effects likely place the populations at greater risk when stochastic events occur (K. Bradley, pers. comm. 2009). The entire taxon is threatened with extinction during these events.

During the winter dry season, plants become desiccated without periodic rainfall. During the summer wet season, plants recover. Multi-year droughts may negatively impact populations. While droughts are natural events, they are a threat because there are so few Florida bristle fern occurrences. Similarly, hurricanes and tropical storms can damage canopy trees which provide shade, and may sometimes extirpate colonies. For example, Hurricane Andrew in 1992 may be responsible for the loss of Florida bristle fern from Hattie Bauer Hammock. The taxon was seen at the site a few years before the hurricane, but has not been documented there since. Hurricane Andrew temporarily destroyed the canopy at the site, and the increase of sunlight in the several years after the storm may have eliminated the occurrence, which was already stressed by drainage (K. Bradley, pers. comm. 2007).

Invasive exotic plants are also a threat to the rockland hammock habitat and Florida bristle fern. These plants outcompete and displace the Florida bristle fern in solution holes and cause overshadowing and the formation of dense strata in hammocks, thereby altering habitats and habitat conditions (K. Bradley, pers. comm. 2010). The most problematic invasive plants in Miami-Dade County associated with Florida bristle fern include Brazilian-pepper (*Schinus terebinthifolius*), bishop wood (*Bischofia javanica*), American evergreen (*Syngonium podophyllum*), Brazilian jasmine (*Jasminum fluminense*), mysore raspberry (*Rubus niveus*), and java plum (*Syzygium cumini*) (K. Bradley, pers. comm. 2007). During a site visit to Meissner Hammock in November 2008, a Queensland umbrella tree (*Schefflera actinophylla*) was found growing out of the solution hole containing the Florida bristle fern (K. Bradley, pers. comm. 2008). In Sumter County, the most problematic invasive species in Florida bristle fern habitat are air potato (*Dioscorea bulbifera*), tuberous sword fern (*Nephrolepis cordifolia*), skunkvine (*Paederia foetida*), and scratchthroat (*Ardisia crenata*) (C. Werner, pers. comm. 2007). Because plants in Sumter County occur close to an agricultural field, encroachment of exotic plants at this site is a serious concern (C. Werner, pers. comm. 2007) since a nearby seed source exists. Both Miami-Dade County and the State of Florida have ongoing exotic plant management programs to reduce threats from exotic plants on public lands, as funding and resources allow. However, exotic plants will

always be a threat to this species (K. Bradley, pers. comm. 2008). At least 162 species of exotics are known to invade tropical hardwood hammocks in south Florida, and impacts are particularly severe on the Miami Rock Ridge (Service 1999, p. 3-135). In some cases, exotic species comprise 50 percent of the flora in hammock fragments in this area (Service 1999, p. 3-135). Any occurrences on private lands in Sumter County (or Miami-Dade County) would also be impacted by invasive exotic plants. This threat is expected to continue due to: the number and extent of exotics, their abilities to out-compete native species, the abundance of seed sources, the extent of disturbance within habitats, the difficulty in managing hammock fragments, and limitations in resources to combat the problem.

Little public use occurs in the vicinity of the Florida bristle fern colonies. In Miami-Dade County, one of the three sites is open to the public. If public use became more intense, it could threaten the colonies. Since the taxon grows along the rim and walls of solution holes, people climbing into these holes could damage colonies. Similarly, climbing on boulders where the fern occurs in Sumter County could cause damage. This is a potential threat that does not appear to be occurring at this time.

Fires may have impacted colonies of Florida bristle fern in the past. Craighead (1963, p. 39) noted that extensive fires in hammocks eliminated ferns in much of their former range. While fires are a natural component of some ecosystems in south Florida, fires in hammocks result in succession to pine rockland or other communities and will directly kill many plant species that are not adapted to fires. Fires typically only burn hammocks in time of droughts or when they are intentionally set. This may have been a factor in the disappearance of the species in Royal Palm Hammock, which suffered from multiple fires in the first half of the 1900s. In recent decades, fires have not been a problem in most rockland hammocks in urbanized Miami-Dade County, but it does remain as a potential threat, especially during periods of prolonged drought.

In summary, population size and number of populations and genetic variability are low, and this increases the inherent risk due to stochastic events, including droughts, tropical storms, and hurricanes. Resiliency is low; stressors such as drainage effects likely place populations at greater risk when stochastic events occur (K. Bradley, pers. comm. 2009). The threats of few occurrences, low population size, and reduced genetic diversity are severe and imminent. Droughts and hurricanes are imminent threats of moderate magnitude. Invasive exotic species are moderate and nonimminent because actions are being taken to reduce this threat. The potential threats of public use and fire at extant sites are low and nonimminent.

**CONSERVATION MEASURES PLANNED OR IMPLEMENTED:** All public conservation lands where the species occurs have ongoing management programs, including control of exotic plants. Nevertheless, exotic plants are likely to always be a pervasive threat.

Surveys for the taxon were conducted in Royal Palm Hammock in ENP in 2003 and 2004 (Gann *et al.* 2006, p. 37). No plants were found during these surveys, so steps towards reintroduction began. Plants collected from the wild are being grown by the Marie Selby Botanic Gardens and the Carl H. Lindner, Jr. Family Center for Conservation and Research of Endangered Wildlife (CREW) at the Cincinnati Zoo and Botanical Garden (Possley and Maschinsky 2006, p. 27;

Gann and Hines 2007, p. 5). There are plans to reintroduce the taxon to two sites where it formerly occurred, Royal Palm Hammock (ENP) and Hattie Bauer Hammock (Miami-Dade County preserve). In 2006, FTBG collected 15 fronds from five individuals; material is being maintained in FTBG's *ex situ* collection until reintroduction (Maschinski *et al.* 2006, p. 1).

FTBG received three colonies from CREW in 2008 (Possley and Maschinski 2009, p. 21). The colonies are housed in a terrarium and appear healthy, but are slow-growing (Possley and Maschinski 2009, p. 21). Experiments with different light levels and media will be conducted to try to encourage growth (Possley and Maschinski 2009, p. 21).

Both FTBG and CREW are working on refining cultivation methods and growing healthy specimens, and CREW has had some success cryopreserving sporophytes (Possley and Maschinski 2009, p. 16). *In vitro* material is growing well at CREW and supplementing material, which is being grown in soil boxes (Possley and Maschinski 2009, p. 20). A preliminary test on the feasibility of cryopreserving this tissue was conducted using *in vitro* cultures (Possley and Maschinski 2009, p. 20). Sporophyte material survived drying and liquid nitrogen freezing, using an encapsulation dehydration method, particularly when the stress hormone, abscisic acid, was used as a pretreatment (Possley and Maschinski 2009, p. 20-21). These procedures might be used to maintain genetic material *ex situ* in long-term storage because spores would be more difficult to obtain (Possley and Maschinski 2009, p. 20-21).

**SUMMARY OF THREATS:** Florida bristle fern is threatened with extinction because of long-term human influences. Most sites where Florida bristle fern once occurred in Miami-Dade County have been lost; little rockland hammock remains outside of ENP, and the species no longer occurs within ENP. Impacts from regional drainage in Miami-Dade County are severe and currently occurring. Regional drainage in remaining habitat has probably been a stressor that has contributed to extirpations and population declines (Nauman 1986, p. 182). Resulting drops in ambient humidity in the taxon's habitat may limit reproduction and health of populations over the long-term. Such changes in humidity may cause extirpations or make plants more vulnerable to other stressors (e.g., periodic long-term droughts, hurricanes). Climatic changes and sea level rise are future, long-term threats that are expected to impact habitat and ultimately reduce the extent of available habitat in Miami-Dade County. Agricultural conversion and development are currently occurring in Sumter County, placing any undocumented occurrences and suitable habitat at risk. Since a full survey of suitable habitats for Florida bristle fern has never been conducted in Sumter County, we cannot determine the extent of losses of this species due to habitat destruction and modification nor the magnitude and immediacy of current threats. The Florida bristle fern has been reduced to four known occurrences, which are small and isolated. All occur on conservation lands; however, there is potential, especially in Sumter County, for the species to occur on private lands. Together, the extant occurrences contain fewer than 1,000 plants (K. Bradley, pers. comm. 2007). Many plants are probably clones, so there may be limited genetic diversity within sites (K. Bradley, pers. comm. 2007). Because there are few occurrences, populations contain few plants, and genetic variability is low, the species is inherently at risk due to stochastic events (Matthies *et al.* 2004, p. 481-488). Stochastic events are expected to exacerbate the impacts of regional drainage and subsequent drops in humidity and cause extirpations. Droughts, tropical storms, and hurricanes are threats. Since few occurrences remain, the entire taxon is threatened with extinction during

these events. Invasive exotic plants are also a threat, but may be reduced on public lands due to active programs by Miami-Dade County and the State. The extent to which fungus is a threat to wild populations is unknown. The impacts of habitat fragmentation are unknown. Fire and public use at extant sites are potential threats.

**RECOMMENDED CONSERVATION MEASURES:** The largest benefit to this taxon would result from increasing the level of the ground water table under hammocks with current or historic populations of Florida bristle fern. This action is not feasible because increasing ground water levels would increase the risk of flooding in populated areas and agricultural lands.

Other priority actions include:

- Searches for new occurrences and all potential suitable habitat in and around Sumter County
- Searches in historically occupied areas in Miami-Dade County
- Continued removal of exotic plants
- Immediate restoration of canopy cover (with shade cloth if needed) over existing colonies after hurricanes or other events which cause loss of canopy
- Exploring the potential benefits of watering of colonies during extended drought periods
- Exploring the feasibility of pumping water into solution holes that support rare ferns to increase water and humidity levels.
- Augmentation of existing occurrences through outplantings
- Reintroductions of extirpated occurrences through outplantings
- Continued protection of habitats from public use
- Long-term monitoring of all occurrences
- Initiation of life-history and genetic studies. Specifically, information is needed on longevity, growth rates, recruitment rates, reproductive requirements, dispersal methods, and genetic variation.
- Assessing the extent to which fungus may be a threat in the wild
- Promoting a higher regional water table on the Miami Rock Ridge
- Establishing a monitoring program at Withlacoochee State Forest

#### LISTING PRIORITY

THREAT			
Magnitude	Immediacy	Taxonomy	Priority
<b>High</b>	<b>Imminent</b>	Monotypic genus	1
		Species	2
		<b>Subspecies/population</b>	<b>3</b>
	Nonimminent	Monotypic genus	4
		Species	5
		Subspecies/population	6
Moderate	Imminent	Monotypic genus	7

to Low	Nonimminent	Species	8
		Subspecies/population	9
		Monotypic genus	10
		Species	11
		Subspecies/population	12

Rationale for listing priority number:

*Magnitude:* There are few extant occurrences; each is small and isolated. Occurrences in Miami-Dade County are under stress due to regional drainage. This is a major, permanent threat that will not be easily ameliorated. Resulting drops in ambient humidity in the taxon's habitat may limit reproduction and health of populations over the long-term, cause extirpations, or make plants more vulnerable to other stressors (e.g., periodic long-term droughts, hurricanes). Most sites where Florida bristle fern once occurred in Miami-Dade County have been lost.

Agricultural conversion and development are potential threats in Sumter County, in places where Florida bristle fern still occurs on private lands. Since a full survey of suitable habitats for Florida bristle fern has never been conducted in Sumter County, we cannot determine the extent of losses due to habitat destruction and modification or magnitude of threats. Climatic changes and sea level rise are serious, long-term threats that will reduce the extent of habitat. Overall, the threat of habitat loss and modification is high. There are few occurrences, populations contain few plants, and genetic variability is probably low; therefore, the species is inherently at risk due to stochastic events (Matthies *et al.* 2004, p. 481-488), which may result in extirpation.

Populations are expected to decline unless corrective action is taken. Exotic plant control, water management, and maintaining canopy gaps after hurricanes are recommended actions that may increase the probability of persistence. The extent to which fungus is a threat to wild populations and the impacts of habitat fragmentation are unknown. Fire and public use at extant sites are potential threats, the magnitude of which is low. Overall, magnitude of threats is high.

*Imminence:* All known occurrences in Miami-Dade County are currently threatened by regional drainage. Regional drainage is an on-going, chronic, and persistent problem that will be difficult to address. It likely affects occurrences slowly by limiting reproduction and dispersal, and quickly during stochastic events like hurricanes. Existing occurrences are expected to continue to decline due to lower ambient humidity in hammocks, and then disappear after hurricanes temporarily destroy tree canopies, subjecting the plants to reduced humidity levels and increases in direct sunlight. Corrective and innovative approaches are needed to reduce the extent and immediacy of this threat. Immediate actions to provide canopy may be needed following events such as hurricanes. Sea level rise is currently occurring, but is a future, long-term threat for the occurrences in Miami-Dade County since we do not have any evidence that it is currently affecting any population. Remaining occurrences are small and isolated; it is not known if they are viable. Many plants are probably clones, so there may be limited genetic diversity within sites. The Florida bristle fern is inherently at risk due to stochastic events. Hurricane Andrew may have contributed to the extirpation at two sites. Hurricanes and other stochastic events continue to place this species at risk due to its few occurrences, small number of individuals, and apparent lack of genetic variability. The threats caused by fungus and habitat fragmentation are potential and nonimminent. The threat from exotic species is currently occurring, but is



nonimminent due to management on public lands. The threats of fire and public use at occupied sites are nonimminent. Overall, the most serious threats are imminent.

Rationale for Change in Listing Priority Number (insert if appropriate): Not applicable.

Yes Have you promptly reviewed all of the information received regarding the species for the purpose of determining whether emergency listing is needed?

Is Emergency Listing Warranted? No. The status of Florida bristle fern is precarious and needs to be followed closely. This plant persists on conservation lands. With proper management, some threats to this species can be removed or reduced.

DESCRIPTION OF MONITORING: The Service has conducted extensive literature searches and obtained all recent and most historical documents pertaining to Florida bristle fern. Data on historical locations has been obtained by compiling herbarium specimens from herbaria in Florida (Archbold Biological Station, FTBG, Florida State University, University of South Florida), the New York Botanical Garden, Harvard University Herbaria, and the Smithsonian Institution. Specimens at the University of Florida need to be reviewed. Data have been received from the FNAI. Many botanists, biologists, naturalists, and land managers in Florida were contacted, including Keith Bradley, Alan Cressler, David Hall, Bruce Hansen, Amy Jenkins, Gil Nelson, Jennifer Possley, Jimi Sadle, Daniel Ward, Colleen Werner, and Richard Wunderlin. A literature review was conducted to find any literature relevant to this taxon. In addition, the botanical notes of George Avery, in the archives of FTBG and in the archives of IRC were reviewed.

FTBG is actively monitoring the species at known sites in Miami-Dade County. Monitoring of the three Miami-Dade County occurrences began in 2003 (Possley and Maschinski 2003, p. 15, 19). There is no monitoring program in place at Withlacoochee State Forest.

#### COORDINATION WITH STATES

Indicate which State(s) (within the range of the species) provided information or comments on the species or latest species assessment: The Service requested new information (observations, data, reports) regarding the status of this plant or any new information regarding threats to this species from Florida Department of Agriculture and Consumer Services, National Park Service, Service (National Wildlife Refuges), Florida Department of Environmental Protection, Miami-Dade County, Florida Fish and Wildlife Commission, FNAI, IRC, Historic Bok Sanctuary, The Nature Conservancy, FTBG, Archbold Biological Station, NatureServe, Miami University, University of Central Florida, Florida International University, University of Florida, Princeton, members of the Rare Plant Task Force, botanists, and others. In total, a previous version of this assessment was sent to approximately 200 individuals on January 7, 2010.

Indicate which State(s) did not provide any information or comments: None.

#### LITERATURE CITED

- Austin, D.F., A.F. Cholewa, R.B. Lassiter, and B.F. Hansen. 1987. The Florida of John Kunkel Small: his species and types, collecting localities, bibliography and selected reprinted works. Contributions from the New York Botanical Garden. Volume 18.
- Bradley, K. 2007. Email to Paula Halupa. The Institute for Regional Conservation. Miami, Florida. September 12, 2007.
- Bradley, K. 2008. Email to Paula Halupa. The Institute for Regional Conservation. Miami, Florida. December 9, 2008.
- Bradley, K. 2009. Email to Paula Halupa. The Institute for Regional Conservation. Miami, Florida. May 20, 2009.
- Bradley, K. 2010. Telephone conversation with Paula Halupa. The Institute for Regional Conservation. Miami, Florida. May 26, 2010.
- Craighead, F.C. 1963. Orchids and Other Air plants of the Everglades National Park. University of Miami Press, Coral Gables, Florida.
- Darling, T. 1961. Florida rarities. American Fern Journal 51(1):1-15.
- Eaton, A.A. 1906. Pteridophytes observed during three excursions into southern Florida. Bulletin of the Torrey Botanical Club 33(9):455-486.
- Flora of North America Editorial Committee. 1993. Flora of North America. Volume 2: Pteridophytes and Gymnosperms. Oxford University Press, New York.
- Florida Natural Areas Inventory. 2010a. FNAI element tracking summary. Tallahassee, Florida. March 30, 2010.  
[http://www.fnai.org/PDF/Element\\_tracking\\_summary\\_201003.pdf](http://www.fnai.org/PDF/Element_tracking_summary_201003.pdf)  
[Accessed: April 2, 2010].
- Florida Natural Areas Inventory. 2010b. FNAI tracking list. Plants and Lichens. Florida: all counties. Tallahassee, Florida. <http://www.fnai.org/bioticssearch.cfm>  
[Accessed: April 2, 2010].
- Gann, G.D., K.A. Bradley, and S.W. Woodmansee. 2002. Rare Plants of South Florida: Their History, Conservation, and Restoration. Institute for Regional Conservation, Miami, Florida.
- Gann, G.D., K.A. Bradley and S.W. Woodmansee. 2001-2008. The floristic inventory of south florida database online. The Institute for Regional Conservation, Miami, Florida.  
<http://regionalconservation.org/ircs/database/plants/PlantPage.asp?TXCODE=Tricpuncflor>  
[Accessed: April 12, 2010]


- Gann, G.D., and K.N. Hines. 2007. Rare plant monitoring and restoration on Long Pine Key, Everglades National Park. Report submitted to Everglades National Park. The Institute for Regional Conservation, Miami, Florida.
- Gann, G.D., K.N. Hines, E.V. Grahl, and S.W. Woodmansee. 2006. Rare plant monitoring and restoration on Long Pine Key, Everglades National Park. Report submitted to Everglades National Park. The Institute for Regional Conservation, Miami, Florida.
- Hill, S.R. 2003. Conservation assessment for Appalachian Bristle Fern (*Trichomanes boschianum*) Sturm. Report submitted to U.S.D.A. Forest Service, Eastern Region by Illinois Natural History Survey, Champaign, Illinois.
- Integrated Taxonomic Information System. 2010. ITIS standard report page: *Trichomanes punctatum* ssp. *floridanum* W. Boer <http://www.itis.gov/servlet/SingleRpt/SingleRpt> [Accessed April 8, 2010].
- Intergovernmental Panel on Climate Change. 2007. Summary for policymakers, In: Climate Change 2007: the Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor, and H.L. Miller, Editors]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.
- Intergovernmental Panel on Climate Change. 2008. Climate Change and Water [B.C. Bates, Z.W. Kundzewicz, S. Wu, and J.P. Palutikof, Editors]. Technical Paper of the Intergovernmental Panel on Climate Change. Intergovernmental Panel on Climate Change Secretariat, Geneva, Switzerland.
- Lakela, O., and R.W. Long. 1976. Ferns of Florida – An Illustrated Manual and Identification Guide. Banyan Books, Miami, Florida.
- Lellinger, D.B. 1985. A Field Manual of the Ferns and Fern-allies of the United States and Canada. Smithsonian Institution Press, Washington, D.C.
- Lodge, T.E. 2005. The Everglades Handbook: Understanding the Ecosystem. CRC Press, Boca Raton, Florida.
- Long, R.W., and O. Lakela. 1971. A Flora of Tropical Florida – A Manual of the Seed Plants and Ferns of Southern Peninsular Florida. University of Miami Press, Coral Gables, Florida.
- Maschinski, J., K.S. Wendleberger, S.J. Wright, J. Possley, D. Walters, J. Roncal, and J. Fisher. 2006. Conservation of south Florida endangered and threatened flora: 2005 program at Fairchild Tropical Garden. Final report contract: #009706. Florida Department of Agriculture and Consumer Services, Division of Plant Industry, Gainesville, Florida. June 2006.

- Matthies, D., I. Bräuer, W. Maibom, and T. Tschardtke. 2004. Population size and the risk of local extinction: empirical evidence from rare plants. *Oikos* 105:481-488.
- Miami-Dade County Climate Change Task Force, Science and Technology Committee. 2008. Statement on sea level in the coming century. January 17, 2008. Miami-Dade County, Florida.
- National Oceanographic and Atmospheric Administration. 2008. Sea Levels Online (Mean sea level trend 8724580 Key West, Florida). National Ocean Service, Center for Operational Oceanographic Products and Services. Online [<http://tidesandcurrents.noaa.gov>]. [Accessed: October 17, 2008].
- NatureServe. 2009. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. <http://www.natureserve.org/explorer>. [Accessed: April 12, 2010].
- Nauman, C.E. 1986. *Trichomanes* in Florida. *American Fern Journal* 76(4):179-183.
- Nelson, G. 2000. The Ferns of Florida – A Reference and Field Guide. Pineapple Press, Sarasota, Florida.
- Possley, J. 2007. Email to Keith Bradley. Fairchild Tropical Botanic Garden. Coral Gables, Florida. July 13, 2007.
- Possley, J. 2008. Email to Paula Halupa. Fairchild Tropical Botanic Garden. Coral Gables, Florida. October 10, 2008.
- Possley, J., and J. Maschinski. 2003. Development and implementation of a biological monitoring program for rare plants in Miami-Dade County natural areas. Report to Miami-Dade County. Fairchild Tropical Garden, Miami, Florida.
- Possley, J., and J. Maschinski. 2006. Development and implementation of a biological monitoring program for rare plants in Miami-Dade County natural areas. Report to Miami-Dade County. Fairchild Tropical Botanic Garden, Miami, Florida.
- Possley, J., and J. Maschinski. 2009. Year 6 report: biological monitoring for plant conservation in Miami-Dade County natural areas. Miami-Dade County Resolution #R-808-07.
- Ross, M.S., J.F. Meeder, J.P. Sah, P.L. Ruiz and G.J. Telesnicki. 2000. The southeast saline Everglades revisited: 50 years of coastal vegetation change. *Journal of Vegetation Science* 11:101–112.
- Ross, M.S., J.J. O'Brien, and L. da Silveira Lobo Sternberg. 1994. Sea-level rise and the reduction in pine forests in the Florida Keys. *Ecological Applications* 4:144-156.

- Sadle, J. 2008a. Email to Paula Halupa. Everglades National Park. Homestead, Florida. October 10, 2008.
- Sadle, J. 2008b. Email to Paula Halupa. Everglades National Park. Homestead, Florida. January 23, 2008.
- Small, J.K. 1913. Flora of the Southeastern United States. Second edition. Published by the author, New York.
- Small, J.K. 1918a. Ferns of Tropical Florida. Published by the author, New York.
- Small, J.K. 1918b. Ferns of Royal Palm Hammock. Published by the author, New York.
- Small, J.K. 1931. Ferns of Florida. The Science Press, New York.
- Small, J.K. 1938. Ferns of the Southeastern States. The Science Press, Lancaster, Pennsylvania.
- Snyder, J.R., A. Herndon, and W.B. Robertson, Jr. 1990. South Florida rocklands. Pages 230-277 in R.L. Myers and J.J. Ewel, eds. Ecosystems of Florida. University of Central Florida Press, Orlando, Florida.
- Underwood, L.M. 1906. American ferns – VI. Species added to the flora of the United States from 1900 to 1905. Bulletin of the Torrey Botanical Club 33(3):189-205.
- U.S. Climate Change Science Program. 2008. Preliminary review of adaptation options for climate-sensitive ecosystems and resources. A Report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research. [Julius, S.H., J.M. West (eds.), J.S. Baron, L.A. Joyce, P. Kareiva, B.D. Keller, M.A. Palmer, C.H. Peterson, and J.M. Scott (Authors)]. U.S. Environmental Protection Agency, Washington, DC.
- U.S. Fish and Wildlife Service (Service). 1999. South Florida multi species recovery plan. U.S. Fish and Wildlife Service, Atlanta, Georgia.
- Werner, C. 2007. Withlacoochee State Forest pers. comm. to The Institute for Regional Conservation (IRC), Miami, Florida.
- Wessels Boer, J.G. 1962. The new world species of *Trichomanes* Sect. *Didymoglossum* and *Microgonium*. Acta Botanica Neerlandica 11:277-330.
- Wherry, E.T. 1964. The Southern Fern Guide. Doubleday and Company, New York.
- Williams, K.L., K.C. Ewel, R.P. Stumpf, F.E. Putz and T.W. Workman. 1999. Sea-level rise and coastal forest retreat on the west coast of Florida. Ecology 80:2045–2063.
- Wunderlin, R.P. 1982. Guide to the Vascular Plants of Central Florida. University Presses of Florida, Tampa, Florida.

- Wunderlin, R.P. 1998. Guide to the Vascular Plants of Florida. University Press of Florida, Gainesville, Florida.
- Wunderlin, R.P., and B.F. Hansen. 2000. Flora of Florida, Volume 1: Pteridophytes and Gymnosperms. University Press of Florida, Gainesville, Florida.
- Wunderlin, R.P., and B.F. Hansen. 2003. Guide to the Vascular Plants of Florida, Second edition. University Press of Florida, Gainesville, Florida.
- Wunderlin, R. P., and B. F. Hansen. 2008. Atlas of Florida Vascular Plants (<http://www.plantatlas.usf.edu/>). [S. M. Landry and K. N. Campbell (application development), Florida Center for Community Design and Research.] Institute for Systematic Botany, University of South Florida, Tampa, Florida. [accessed April 8, 2010]

APPROVAL/CONCURRENCE: Lead Regions must obtain written concurrence from all other Regions within the range of the species before recommending changes, including elevations or removals from candidate status and listing priority changes; the Regional Director must approve all such recommendations. The Director must concur on all resubmitted 12-month petition findings, additions or removal of species from candidate status, and listing priority changes.

Approve:  June 15, 2010  
for Regional Director, Fish and Wildlife Service Date

Concur: \_\_\_\_\_  
Director, Fish and Wildlife Service Date

Do not concur: \_\_\_\_\_  
Director, Fish and Wildlife Service Date

Director's Remarks:

Date of annual review: April 19, 2010

Conducted by: Paula Halupa, South Florida Ecological Services Office